Mini-Circuit ZADC-6-30-1
6 dB Directional Coupler
Tests

Test procedure

Mini-Circuits ZADC-6-30-1

Frequency Range (MHz)	Insertion Loss (dB)	Coupling (dB)	Directivity (dB)	VSWR	Ports
2700 - 3000	1.6 $\pm$ 0.4 dB	6.5 $\pm$ 1.0 dB	22.0 $\pm$ 5.0	1.3	SMA Female

Equipment List

Item	MFG.	Part Number	Notes
Power meter	Agilent	E4418B	Single channel
6 dB dir. coupler	Mini-Circuits	ZADC-6-30-1	6 dB coupling
Universal adapter kit	Pomona	5698	Adapter kit
Cables	Pasternack	PE3481	18” and 36” cables
Signal generator	Agilent	8648D	9 kHz to 4 GHz
Power sensor	Agilent	8481A	-30 dBm to + 20 dBm

Note: Use properly rated power series sensor. Using incorrect rated power sensor could damage sensor.

Duty cycle = PRF X Pulse width = 10 log (1013.5 Hz X 1.52 microseconds) = -28.12 dB

Turn on power meter, signal generator and spectrum analyzer, wait 30 minutes to warm up.

1) Zero the power meter.
2) Calibrate power sensor.

Use power meter to measure cables and connectors attenuation at different frequencies (2642, 2850, and 2942 MHz). Record results in Tables 1,2, and 3.

Coupling Loss Test Procedure

Coupling factor (dB) = 10 log P_{in} – 10 log $P_{coupled}$

To find the Coupling Losses, inject various levels of RF into the input port. Measure the RF levels from the coupled port with the output port terminated. Vary the LO levels between +13.0 and +14.5 dBm peak at frequencies of 2642, 2850 and 2942 MHz. Use Table 1 to record RF signals coming out of the coupled port.

Use Figure 1 to properly setup the 6 dB coupler.

1) Set LO level = +13.0 dBm and LO frequency = 2642 MHz.
2) Terminate output port.
3) Record measurements of power meter display in Table 1.
4) Add attenuation and cable losses to measured values to determine correct values.

Repeat steps 1 – 4 but change LO levels and frequencies according to Table 1.

Coupling Loss Test

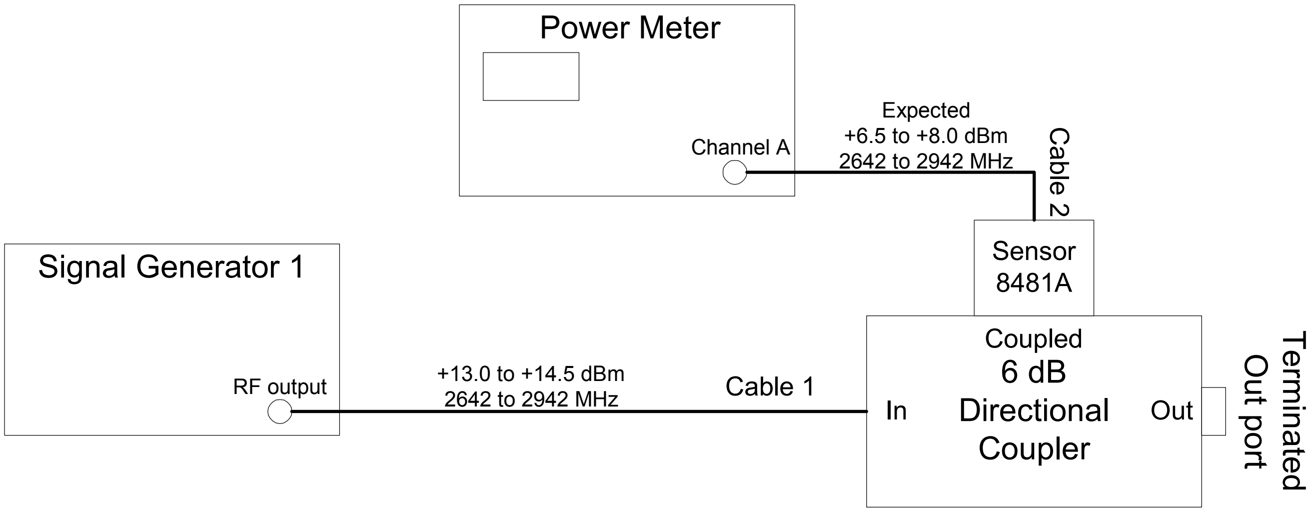

Figure 1

LO (dBm)	LO (MHz)	Expected Coupled (dBm)	Measured Coupled (MHz)	Measured Coupled (dBm)	Corrected[1] Coupled (dBm)	Coupling[2] Loss (dB)
13.00	2642	6.50	2642	5.44	6.20	6.80
13.00	2850	6.50	2850	5.07	5.83	7.17
13.00	2942	6.50	2942	5.21	5.83	7.17
13.50	2642	7.00	2642	5.93	6.69	6.81
13.50	2850	7.00	2850	5.58	6.34	7.16
13.50	2942	7.00	2942	5.71	6.33	7.17
14.00	2642	7.50	2642	6.42	7.18	6.82
14.00	2850	7.50	2850	6.08	6.84	7.16
14.00	2942	7.50	2942	6.21	6.83	7.17
14.50	2642	8.00	2642	6.90	7.66	6.84
14.50	2850	8.00	2850	6.57	7.33	7.17
14.50	2942	8.00	2942	6.72	7.34	7.16

Table 1: Coupling Loss

Expected Coupling Loss: 6.5 $\pm$ 1.0 dB

Cable 1 and Cable 2 loss (57.5 MHz) -0.03 dB.
Cable 1 and Cable 2 loss (2642 MHz) -0.76 dB.
Cable 1 and Cable 2 loss (2850 MHz) -0.76 dB.
Cable 1 and Cable 2 loss (2942 MHz) -0.62 dB.

[1] Corrected Coupled = Measured Coupled + (attenuation and cable losses)
[2] Coupling Loss = LO – Corrected Coupled

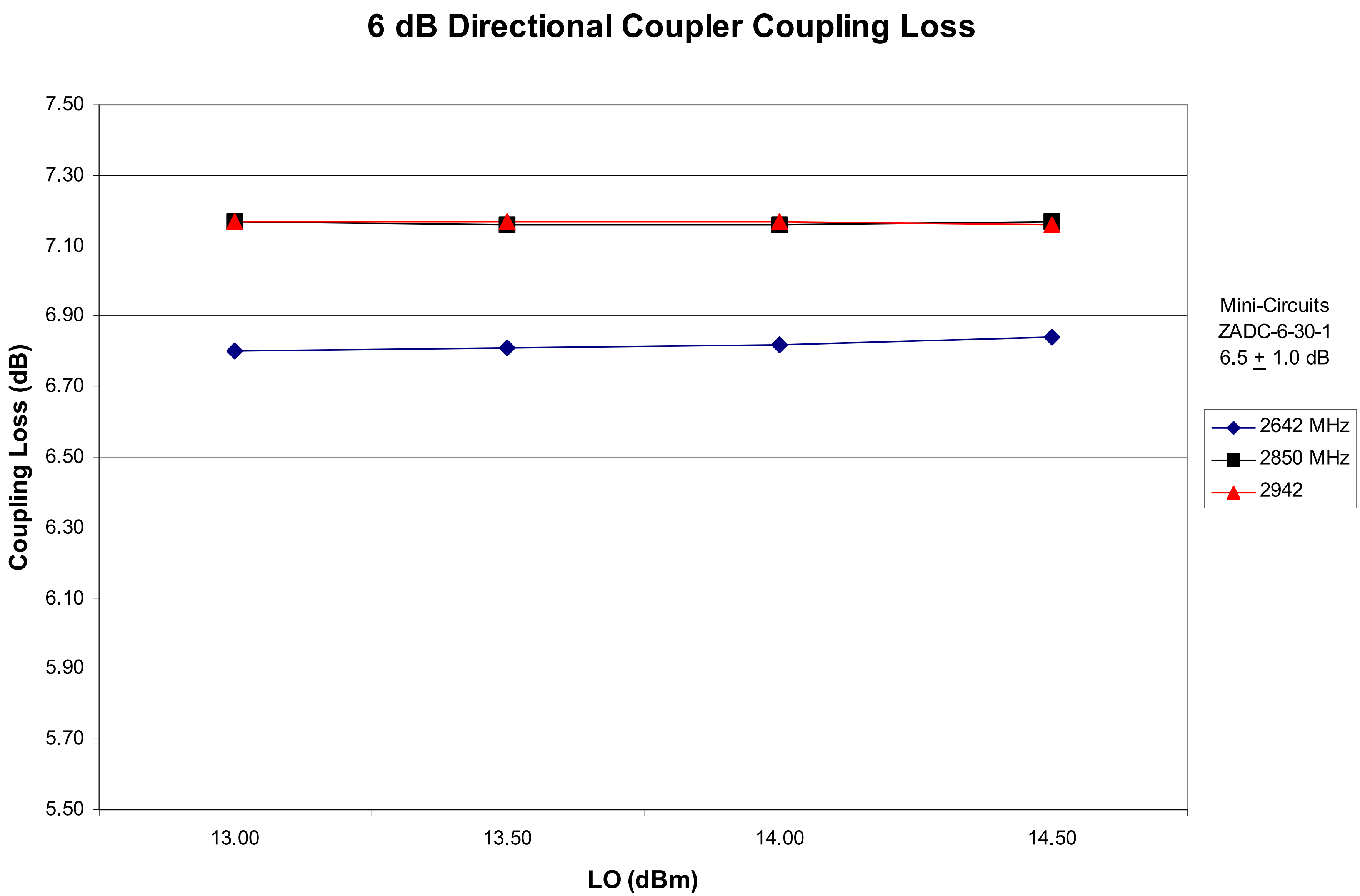
6 dB Directional Coupler Coupling Loss
Coupling Loss (dB)
7.50
7.30
7.10
6.90
6.70
6.50
6.30
6.10
5.90
5.70
5.50
13.00
13.50
14.00
14.50
LO (dBm)
Mini-Circuits
ZADC-6-30-1
6.5 ± 1.0 dB
2642 MHz
2850 MHz
2942

Chart 1

Insertion Loss Test Procedure

Insertion Loss (dB) = 10 log P_{in} – 10 log P_{out}
Where P_{in} is the power incident at the In port at f_{LO}
P_{out} is the output power at the Out port at f_{LO}

To find the Insertion Losses, inject various levels of RF into the input port. Measure the RF levels from the output port with the coupled port terminated. Vary the LO levels between +13.0 and +14.5 dBm peak at frequencies of 2642, 2850, and 2942 MHz. Use Table 2 to record RF signals coming out of the output port.

Use Figure 2 to properly setup the 6 dB coupler.

1) Set LO level = +13.0 dBm and LO frequency = 2642 MHz.
2) Terminate coupled port.
3) Record measurements of power meter display in Table 2.
4) Add attenuation and cable losses to measured values to determine correct values.

Repeat steps 1 – 4 but change LO levels and frequencies according to Table 2.

Insertion Loss Test

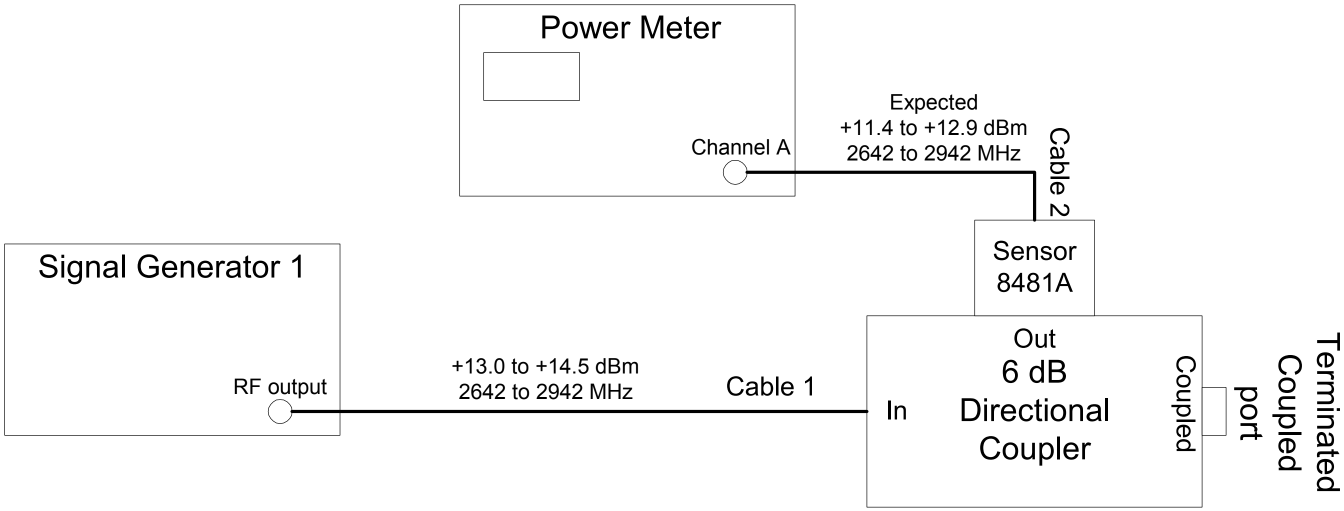

Figure 2

LO (dBm)	LO (MHz)	Expected RF Out (dBm)	Measured RF Out (MHz)	Measured RF Out (dBm)	Corrected[3] RF Out (dBm)	Insertion[4] Loss (dB)
13.00	2642	11.40	2642	10.62	11.38	1.62
13.00	2850	11.40	2850	10.54	11.30	1.70
13.00	2942	11.40	2942	10.85	11.47	1.53
13.50	2642	11.90	2642	11.11	11.87	1.63
13.50	2850	11.90	2850	11.04	11.80	1.70
13.50	2942	11.90	2942	11.35	11.97	1.53
14.00	2642	12.40	2642	11.60	12.36	1.64
14.00	2850	12.40	2850	11.53	12.29	1.71
14.00	2942	12.40	2942	11.84	12.46	1.54
14.50	2642	12.90	2642	12.20	12.96	1.54
14.50	2850	12.90	2850	12.03	12.79	1.71
14.50	2942	12.90	2942	12.35	12.97	1.53

Table 2: Insertion Loss

Expected Insertion Loss: 1.6 $\pm$ 0.4 dB

Cable 1 and Cable 2 loss (57.5 MHz) ______________ -0.03 dB.
Cable 1 and Cable 2 loss (2642 MHz) ______________ -0.76 dB.
Cable 1 and Cable 2 loss (2850 MHz) ______________ -0.76 dB.
Cable 1 and Cable 2 loss (2942 MHz) ______________ -0.62 dB.

[3] Corrected RF = Measured RF + (attenuation and cable losses)
[4] Insertion Loss = LO – Corrected RF

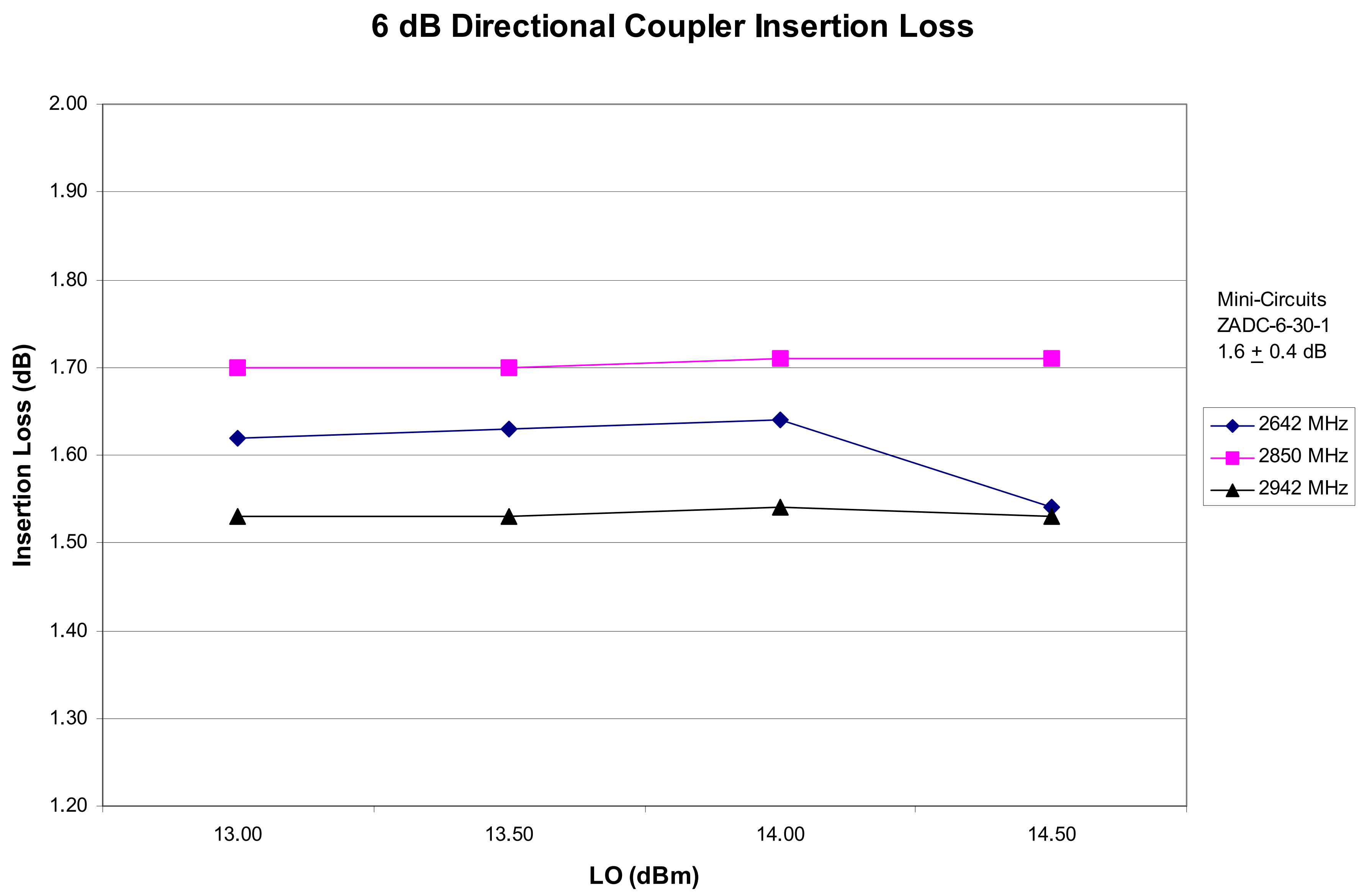
6 dB Directional Coupler Insertion Loss
Insertion Loss (dB)
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
13.00
13.50
14.00
14.50
LO (dBm)
Mini-Circuits
ZADC-6-30-1
1.6 ± 0.4 dB
2642 MHz
2850 MHz
2942 MHz

Chart 2

Isolation loss

Isolation Loss (dB) = 10 log P_{out} – 10 log $P_{coupled}$
Where P_{out} is the power incident at the Out port at f_{LO}
$P_{coupled}$ is the output power at the Coupled port at f_{LO}

To find the Isolation Losses, inject various levels of RF into the output port. Measure the RF levels from the coupled port with the input port terminated. Vary the LO levels between +13.0 and +14.5 dBm peak at frequencies of 2642, 2850, and 2942 MHz. Use Table 3 to record RF signals coming out of the coupled port.

Use Figure 3 to properly setup the 6 dB coupler.

1) Set LO level = +13.0 dBm and LO frequency = 2642 MHz.
2) Terminate input port.
3) Record measurements of power meter display in Table 3.
4) Add attenuation and cable losses to measured values to calculate correct values.
5) Repeat steps 1 – 4 but change LO levels and frequencies according to Table 3.

Directivity

Directivity (dB) = Isolation (dB) – Coupling (dB)

Directivity values are calculated in Table 4.

Isolation Loss Test

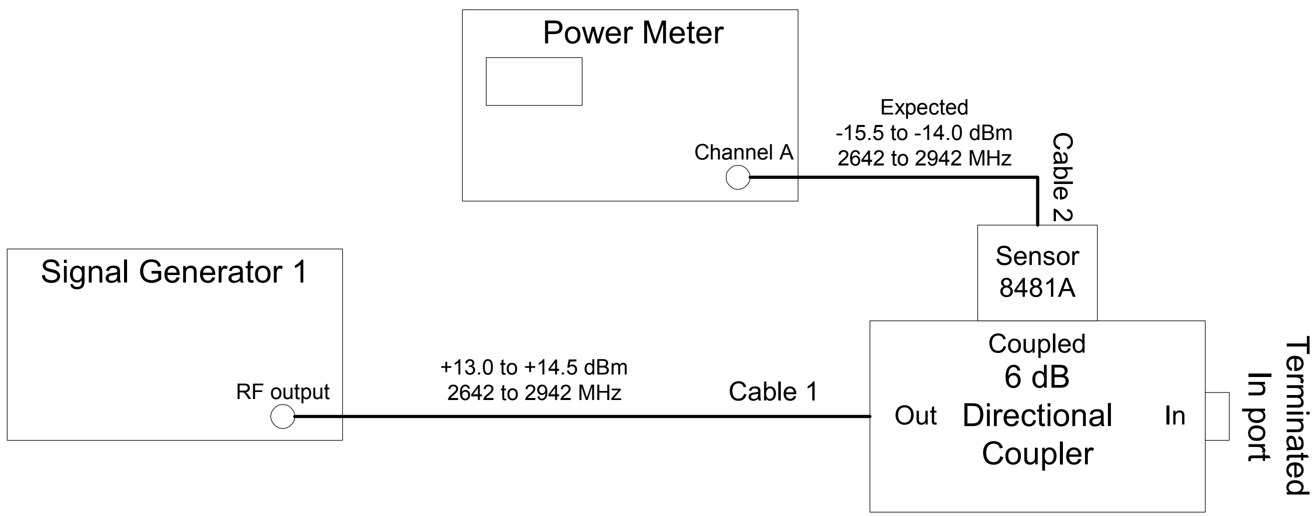

Figure 3

LO (dBm)	LO (MHz)	Expected RF Out (dBm)	Measured RF Out (MHz)	Measured RF Out (dBm)	Corrected[5] RF Out (dBm)	Isolation[6] Loss (dB)
13.00	2642	-15.50	2642	-28.90	-28.14	41.14
13.00	2850	-15.50	2850	-28.73	-27.97	40.97
13.00	2942	-15.50	2942	-28.62	-28.00	41.00
13.50	2642	-15.00	2642	-28.40	-27.64	41.14
13.50	2850	-15.00	2850	-28.20	-27.44	40.94
13.50	2942	-15.00	2942	-28.10	-27.48	40.98
14.00	2642	-14.50	2642	-27.77	-27.01	41.01
14.00	2850	-14.50	2850	-27.58	-26.82	40.82
14.00	2942	-14.50	2942	-27.55	-26.93	40.93
14.50	2642	-14.00	2642	-27.12	-26.36	40.86
14.50	2850	-14.00	2850	-27.00	-26.24	40.74
14.50	2942	-14.00	2942	-27.01	-26.39	40.89

Table 3: Isolation Loss

Expected Isolation Loss: 28.5 $\pm$ 2.0 dB

Cable 1 and Cable 2 loss (57.5 MHz) ______________ -0.03 dB.
Cable 1 and Cable 2 loss (2642 MHz) ______________ -0.76 dB.
Cable 1 and Cable 2 loss (2850 MHz) ______________ -0.76 dB.
Cable 1 and Cable 2 loss (2942 MHz) ______________ -0.62 dB.

[5] Corrected RF = Measured RF + (attenuation and cable losses)
[6] Isolation Loss = LO – Corrected RF

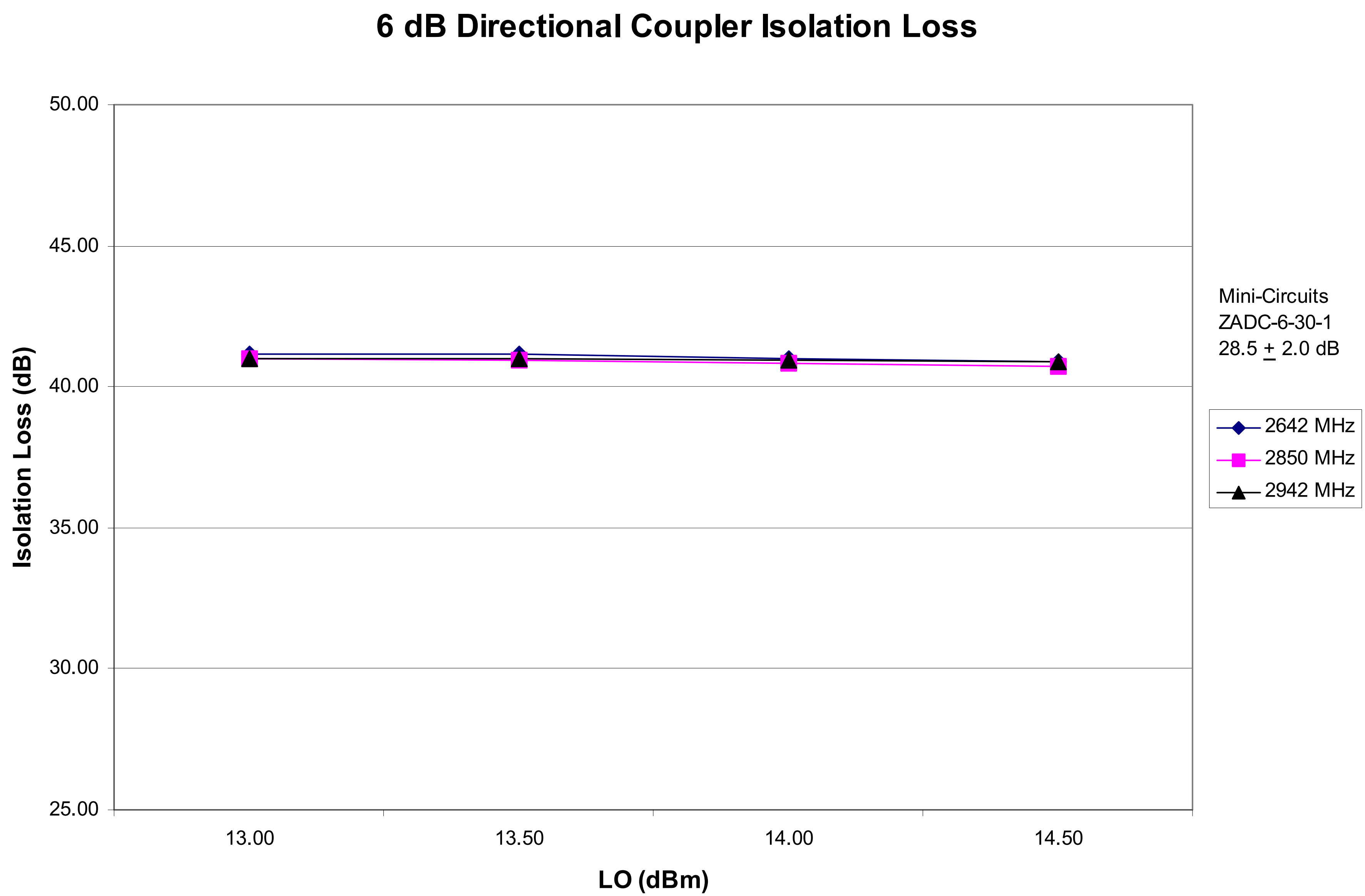
6 dB Directional Coupler Isolation Loss
Isolation Loss (dB)
50.00
45.00
40.00
35.00
30.00
25.00
13.00
13.50
14.00
14.50
LO (dBm)
Mini-Circuits
ZADC-6-30-1
28.5 + 2.0 dB
2642 MHz
2850 MHz
2942 MHz

Chart 3

LO (dBm)	LO (MHz)	Coupling[7] Loss (dB)	Isolation[8] Loss (dB)	Directivity[9] (dB)
13.00	2642	6.80	41.14	34.34
13.00	2850	7.17	40.97	33.80
13.00	2942	7.17	41.00	33.83
13.50	2642	6.81	41.14	34.33
13.50	2850	7.16	40.94	33.78
13.50	2942	7.17	40.98	33.81
14.00	2642	6.82	41.01	34.19
14.00	2850	7.16	40.82	33.66
14.00	2942	7.17	40.93	33.76
14.50	2642	6.84	40.86	34.02
14.50	2850	7.17	40.74	33.57
14.50	2942	7.16	40.89	33.73

Table 4: Directivity

Expected Directivity: 22.0 $\pm$ 5.0 dB

[7] From Table 1
[8] From Table 3
[9] Directivity = Isolation - Coupling

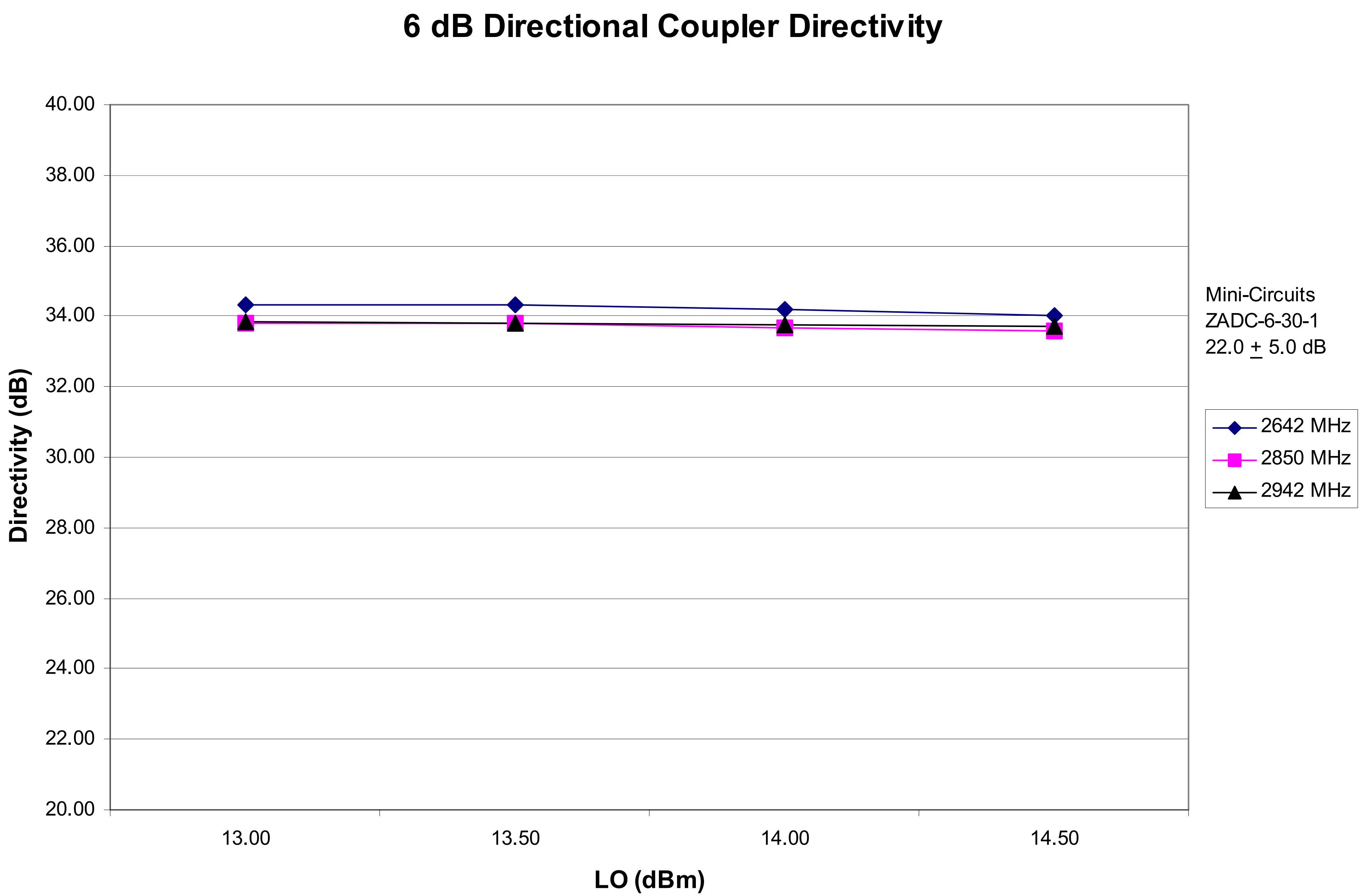
6 dB Directional Coupler Directivity
40.00
38.00
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
Directivity (dB)
13.00
13.50
14.00
14.50
LO (dBm)
Mini-Circuits
ZADC-6-30-1
22.0 ± 5.0 dB
2642 MHz
2850 MHz
2942 MHz

Chart 4

Results

The test results have shown the Mini-circuits 6 dB directional coupler meets most of the RF attenuation requirements. The coupling and insertion losses were within the expected ranges for different power levels and frequencies. These power levels and frequencies are similar to the expected field conditions at the radar sites. The isolation and directivity losses are much higher than expected. These losses maybe a result of a large reflected power loss because of the high RF frequencies. However, higher isolation losses would result in less RF leakage in the coupler. It was also observed during the testing that flexing or bending the SMA cables could cause variances of 0.2 dB. This could cause some readings to be offset by 0.2 dB as seen in the Insertion Loss Chart 2.